OBJECT DETECTION SYSTEM USING HAAR-CLASSIFIER

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Date : 11 MAY 2009

To

My beloved parents

and my siblings

“ who offered me unconditional love and support

throughout the course of this thesis”

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Abstract

The invention of new algorithms had encouraged to the reinforcement of image processing's application. An algorithm for the design object detection systems is presented. Haar-classifier is utilized as the algorithms for this object detection system. The exertion of Haar-Classifier had boosted to the upgrade system which is faster and more accurate. In this system, Haar-Classifier is conjunct with the Adaboost machine learning algorithms wherefore the performance of the system is upgraded. Development of this project is categorized into two phase which are training phase and execution phase. Training phase use OpenCV utilities such as haartraining.exe to train the object by calculating the object's weak constraints. This is for the purpose of finding the different features of the object of interest. The list of these weak constraints is converted to the xml file to be included in the coding which had been developed using Visual Studio 2005. The execution process will result on the detection process of object of interest. System will detect rounded image in any image which had been included in the system itself. Object detection system using Haar-classifier algorithm can perform best performance of high detection rate and high level of accuracy rate.

Abstrak

Penciptaan algoritma baru telah menggalakkan kepada perkembangan aplikasi sistempemprosesan imej. Algoritma untuk mereka sistem pengesanan objek telah diperkenalkan. Pengklasifikasi Haar telah digunakan sebagai algoritma untuk sistem pengesanan objek ini. Penggunaan pengklasifikasi Haar telah meningkatkan prestasi sistem supaya lebih cepat dan tepat. Untuk tujuan meningkatkan kadar pengesanan, pengklasifikasi Haar telah digabungkan dengan kaedah *Adaboost* yang menjadi punca kepada peningkatan kadar pengesanan objek. Pembentukan sistem ini terbahagi kepada dua bahagian iaitu fasa latihan dan fasa perlaksanaan. Fasa latihan menggunakan utiliti *OpenCV* seperti "haartraining.exe" untuk melatih objek yang hendak dikesan dengan cara mengira ciri kelemahan sesuatu objek itu. Hal ini bertujuan untuk mencari ciri-ciri berlainan yang ada pada sesuatu objek itu. Senarai cirri-ciri kelemahan ini ditukar kepada fail xml untuk dimasukkan ke dalam kod yang telah dibuat menggunakan perisian *Visual Studio 2005*. Fasa perlaksaan akan menghasilkan proses pengesanan objeck yang dikehendaki. System akan mengesan image berbentuk bulat dalam sebarang gambar yang telah dimasukkan ke dalam system. Sistem Pengesanan Objek menggunakan pengklasifikasi Haar algoritma mampu melaksanakan hasil yang bagus dengan kadar pengesanan dan kadar ketepatan yang tinggi.

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CHAPTER 1

INTRODUCTION

Development of computer system and technology has encouraged on the development of intelligence on new technologies. Object detection system is developed as a contribution due to help humans in daily life. This system approach can be applied to robotic system and surveillance system. Designing object detection's system is a process to determine the location and the region of the object in a digital image. This system will only detect object of interest and ignore any others objects. The algorithm use in this project is Haar-Training which is used to calculate the threshold of the object of interest in order to obtain a new classifier. This process will be done using OpenCV utilities. Visual Studio 2005 software has been used to test the ability of the new classifier.

1.1 Problem Statement

This project uses the better performance of algorithms such as Haar-Training. for the purpose to get reasonable accuracy rate. Haar-Training could be the better solution as it has a combination with the Adaboost method. The cascade of Adaboosted (Adaptive boost) classifiers can achieve both accuracy and speed. The algorithm can

achieve high detection accuracy and approximately 15 times faster than any previous approaches.

1.2 Objective

The purpose of doing this project is not basically just to detect objects in an image but also for some other purpose which are:

i) To utilize the object's region in a digital images.

ii) To leverage positive object's classifier using Haar-Training.

iii) To develop an object detection system using OpenCV and Visual Studio 2005 software.

1.2.1 Work Scope

There are few work scopes that related to this project which are first to develop a system that can be used to localized object features in a digital colored image. This is for the purpose to identify the location of desired object in an image which also had consisted of other images. Second is to develop a system by using Visual Studio 2005 software for the better performance. Visual Studio is the best software of interfacing OpenCV with GUI interface. Last but not least is to classify the weak and strong features from the desired object using Haar-Classifier to compare with the image's threshold in the xml file (database) for the detection process.

1.4. Project Overview

In general, object detection system's purpose is to detect desired object in any still image. In this project, the desired object input is circle image such as ball, circle and etc. The overall flow of this system can be described as following. A scanned image will be compared to the object models in the system's dataset and the system will detect whether the object exist is or not in an image. This system needs to go through certain important method which are first the collection of image, second is the training process using Haar-Training method, next is coding implementation and last is to match the object with the dataset which in this case was the cascaded image threshold which is contained in the xml file or the purpose to determine whether the desired object is exist or not.

1.5. Thesis Outline

This thesis is organized as follows:

Chapter 1 will describes the introduction of this system, the purpose of doing this project, the problem statement, the work scope and brief explanation of project's system flow.

In **Chapter 2**, the review about the information find on all the material or data used in the development of the system will be shown.

Explanation of all the methods use in development of this system and the step by step solution on developing training part and execution part will be described in **Chapter 3.**

Chapter 4 includes all the results followed with the explanation about the results after all the development process has done.

Chapter 5 is the last chapter and it will show the summary after all and come up with some recommendations for some improvements.

CHAPTER 2

LITERATURE REVIEW

This chapter will review on the information gathered in developing the object detection system. The information accumulated is all the basic notification used in order to develop the system including the basic definition of system approach, the algorithms and the basic process of the system.

2.1 Digital Image Processing

Digital image processing is the use of computer algorithms to perform image processing on digital images **[6].**

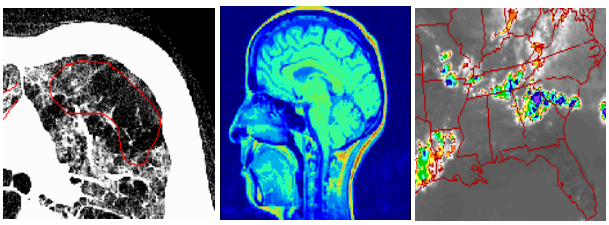

Fig 2.1: Application of Digital Image Processing

2.1.1 Image processing

Image processing is a physical process used to convert an image signal into a physical image. The image signal can be either digital or analog. The actual output itself can be an actual physical image or the characteristics of an image. The most common type of image processing is photography.

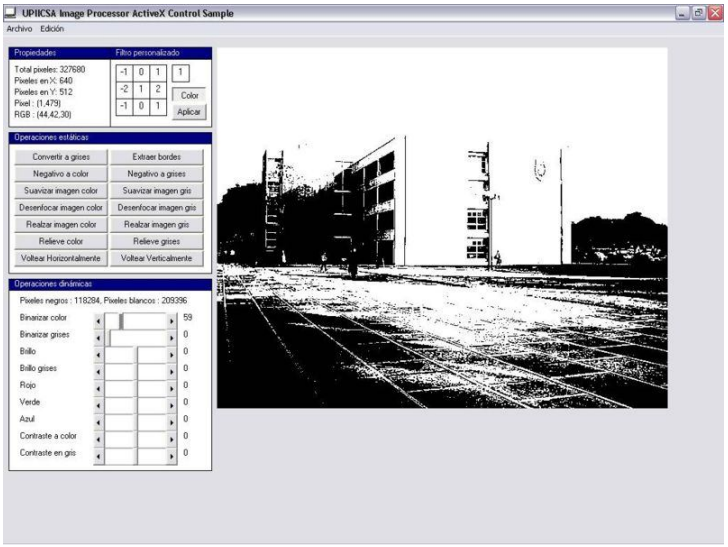

Fig 2.2: Monochrome black/white image

2.1.2 Algorithms

Algorithm is a finite sequence of instructions, an explicit, step-by-step procedure for solving a problem, often used for calculation and data processing. It is formally a type of effective method in which a list of well-defined instructions for completing a task.

In its most general sense, an algorithm is any set of detailed instructions which results in a predictable end-state from a known beginning. Algorithms are only as good

as the instructions given, however, and the result will be incorrect if the algorithm is not properly defined [7].

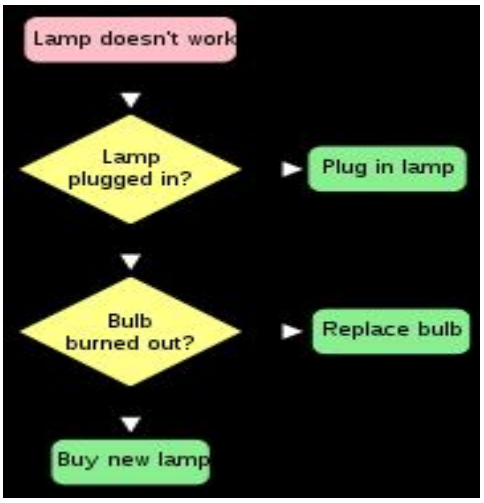

Fig 2.3: Algorithms can be represented in flowchart

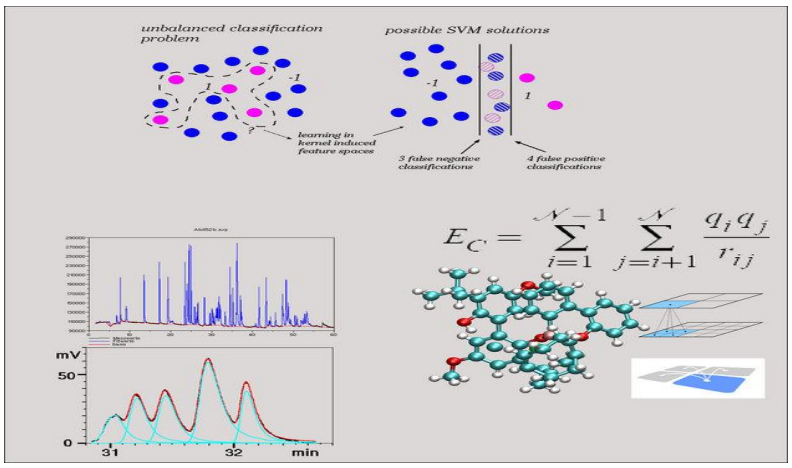

Fig 2.4: Example of Numerical Algorithms

2.2 Edge Detection

An improved algorithm based on frame difference and edge detection is presented for moving object detection. First of all, it detects the edges of each two continuous frames by Canny detector and gets the difference between the two edge

images. And then, it divides the edge difference image into several small blocks and decides if they are moving areas by comparing the number of non-zero pixels to a threshold. At last, it does the block-connected component labeling to get the smallest rectangle that contains the moving object [8]

Fig 2.5: Edge Detection Process

2.3 Color conversion

Threshold is an image segmentation to convert grayscale to binary image. During the threshold process, individual pixels in an image are marked as “object” pixels if their value is greater than some threshold value (assuming an object to be brighter than the background) and as “background” pixels otherwise. This convention is known as *threshold above*. Variants include *threshold below*, which is opposite of threshold above; *threshold inside*, where a pixel is labeled "object" if its value is between two thresholds; and *threshold outside*, which is the opposite of threshold inside. Typically, an object pixel is given a value of “1” while a background pixel is given a value of “0.” Finally, a binary image is created by coloring each pixel white or black, depending on a pixel's label.

Fig 2.6: Result image of grayscale to binary color conversion process.

2.4 Haar-Classifier

Object detection system is given an image patch of known size or a feature and is to decide whether this features stemmed from an object, or a non object. For the purpose to get a reasonable accuracy of object detection performance, the Haar- classifier is applied to this system

Haar-Classifier encodes the existence of oriented contrasts between regions in the image. A set of these features can be used to encode the contrasts exhibited by an object. The detection technique is based on the idea of the wavelet template that defines the shape of an object in terms of a subset of the wavelet coefficients of the image.

Haar-like features are so called because they share an intuitive similarity with the Haar wavelets. Historically, for the task of object recognition, working with only image intensities (i.e. the RGB pixel values at each and every pixel of image) made the task computationally expensive. This feature set considers rectangular regions of the image and sums up the pixels in this region. The value this obtained is used to categorize images. For example, let us say we have an image database with human faces and buildings. It is possible that if the eye and the hair region of the faces are considered, the sum of the pixels in this region would be quite high for the human faces and arbitrarily high or low for the buildings [1]

The value for the latter would depend on the structure of the building, its environment while the values for the former will be more less roughly the same. We could thus categorize all images whose Haar-like feature in this rectangular region to be in a certain range of values as one category and those falling out of this range in another. This might roughly divide the set of images into ones having a lot of faces and a few buildings and the other having a lot of buildings and a few faces. This procedure could be iteratively carried out to further divide the image clusters [2].

The Algorithm use in this project is Haar-like features to find the weak constraints. There is little information that should be understood about Haar-like which are:

- Each Haar-like feature consists of two or three jointed “black” and “white rectangles:

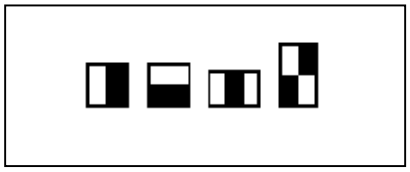

Fig 2.7 : A set of basic Haar-like features.

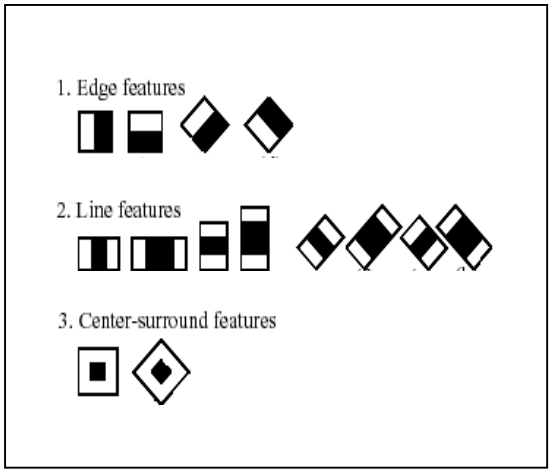

Fig 2.8: A set of extended Haar-like features.

- The value of a Haar-like feature is the difference between the sum of the pixel gray level values within the black and white rectangular regions: